DOCUMENT RESUME

ED 331 725 SE 052 051

AUTHOR Black, Carolyn Bicknell; Crawley, Frank E.
TITLE Student and Parental Message Effects on Urban Hispanic-American Students' Intention to Enroll in High School Chemistry.
PUB DATE 91
NOTE 27p.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Chemistry; *Elective Courses; *Enrollment Influences; *High Schools; *Hispanic Americans; Minority Groups; *Parent Student Relationship; Science Education; Secondary School Science; Urban Youth
IDENTIFIERS *Behavioral Intention

ABSTRACT

This research examined the effects of belief-based messages on the intentions of ninth and tenth grade, Hispanic-American students to enroll in their first elective science course at the pre-college level, chemistry. The design of the study was guided by the theory of planned behavior (Ajzen, 1989) and the Elaboration Likelihood Model of persuasion (Petty & Cacioppo, 1986). Using a posttest, control-group design, messages containing students' salient beliefs about chemistry enrollment were presented to two experimental groups: (1) students and their parents/guardians; and (2) students only. Results revealed no differences in outcomes between the "student-only" message and control groups. On the other hand, students in the "student and parent/guardian" message group surpassed "control" group students on: (1) behavioral intention ($p = .0095$); (2) subjective norm ($p = .0012$); and (3) perceived behavioral control ($p = .0263$) The relative contributions of the three model variables to the prediction of Hispanic-American students' intention to enroll in chemistry also are reported. (Author)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

CAROLYN
BICKNELL BLACK

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ED331725

# Student and Parental Message Effects on Urban Hispanic-American Students' Intention to Enroll in High School Chemistry

Carolyn Bicknell Black and Frank E. Crawley

Science Education Center

University of Texas at Austin

A Contributed Paper presented at the 1991 Annual Meeting of the National Association for Research in Science Teaching, The Abbey, Lake Geneva, Fontana, WI, April 1991.

SE 052051



BEST COPY AVAILABLE

Abstract

This research examined the effects of belief-based messages on the intentions of ninth and tenth grade. Hispanic-American students to enroll in their first elective science course at the pre-college level, chemistry. The design of the study was guided by the theory of planned behavior (Ajzen, 1989) and the Elaboration Likelihood Model of persuasion (Petty & Cacioppo, 1986). Using a posttest, control-group design, messages containing students' salient beliefs about chemistry enrollment were presented to two experimental groups: (a) students and their parents/guardians and (b) students only. Results revealed no differences in outcomes between the "student-only" message and control groups. On the other hand, students in the "student and parent/guardian" message group surpassed "control" group students on (a) behavioral intention ($p = .0095$), (b) subjective norm ($p = .0012$), and (c) perceived behavioral control ($p = .0263$). The relative contributions of the three model variables to the prediction of Hispanic-American students' intention to enroll in chemistry also are reported.

# Student and Parental Message Effects on Urban Hispanic-American Students' Intention to Enroll in High School Chemistry

The shortage of scientists and engineers in the United States predicted for the next decade could be made up, in part, by interesting more women and minorities in these careers (National Science Foundation, 1989). The Hispanic-American minority has been especially underrepresented in science and engineering (U. S. Bureau of the Census, 1980; U. S. Department of Education, 1984, 1987; Vetter, 1989). Determining which personal beliefs, social support systems, and environmental pressures influence Hispanic-American students' precollege science course choice may hold the key to improving their interest in scientific and engineering careers. Data from High School and Beyond (U. S. Department of Education, 1984), reveal that only 26% of Hispanic-American high school seniors had taken chemistry as compared to 39% for their Caucasian counterparts. Further, Hispanic-American college students who switch to science and engineering programs were more likely to have completed fewer high school science courses, particularly chemistry (U.S. Congress, Office of Technology Assessment, 1988). In studies of the Hispanic-American family, MacCorquodale (1983) found that Hispanic-American parents encouraged their children to do well in science and rated science as important. The family has been a relatively untapped supportive resource, and MacCorquodale called upon educators to develop ways of involving parents in assisting their sons and daughters in course selections.

## Purpose

The purpose of this research was to determine the effectiveness of belief-based messages designed to persuade Hispanic-American students to enroll in chemistry. In particular, the study used the salient beliefs provided by students and principles of persuasion and argument construction to design a persuasive message. This message was

presented to students who had not preregistered to enroll in chemistry during the following year, the target behavior. The outcomes of interest included model variables specified in the theory of planned behavior. It was assumed that information gained from the application of models of human behavior and persuasive communication developed by social psychologists would provide new insights into ways that science teachers and science education researchers could enhance interest in advanced science study in high school among Hispanic-American students.

## Theoretical Base

The theory of planned behavior (TPB) (Ajzen, 1985, 1989; Ajzen & Madden, 1986; Schifter & Ajzen,1985) is an extension of the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). Both models were developed to understand and predict human behavior. The TRA model is applicable to volitional behaviors only. Behaviors which depend upon the availability of resources, opportunities, personal expertise, or other people for their performance are explained in the TPB model. Each model identifies intention as the immediate determinant of behavior (Ajzen, 1985, 1987, p. 11). The antecedents of behavioral intention in the TRA model include attitude toward the behavior (AB) and subjective norm (SN). One additional component is included in the TPB model, perceived behavioral control (PBC) to account for situations in which the individual may have incomplete control over performance of the behavior. The contributions of each of the three determinants to the prediction of behavioral intention (BI) and subsequently behavior (B) is described in the following equation:

$$B \sim BI = w_1(AB) + w_2(SN) + w_3(PBC),$$

where $w_1$, $w_2$, and $w_3$ represent the relative contributions of AB, SN, and PBC, respectively.

Beliefs underlie each of the three determinants of behavioral intention. These beliefs represent the salient attributes associated with performance of the behavior. Attributes associated with AB denote the perceived consequences of engaging in the behavior and are called behavioral beliefs. Subjective norm attributes identify personal referents who influence performance of the behavior and are referred to as normative beliefs. Perceived behavioral control attributes designate facilitating and inhibiting factors that effect behavioral performance; these are referred to as control beliefs. Each belief is expressed as an expectancy-value measure (Ajzen, 1985). Expectancy-value measures are added to arrive at a belief-based estimate of AB, SN, and PBC. Detailed descriptions of the theory of planned behavior and the interrelationships among model components can be found in Ajzen (1985, 1988, 1989).

The TRA and TPB models have been used successfully in social psychological studies of many diverse behaviors (Ajzen & Fishbein, 1980). Intention-based studies in science education were first conducted by Stead (1985) in New Zealand to determine intention of students to study science in subsequent years. Subsequently the TRA has been used to predict student enrollment intentions (Crawley & Coe, 1990; Koballa, 1988) and elementary students' intentions to perform science activities (Ray, 1991). Chen (1988) used the TRA to develop messages and determine the effects of persuasive interventions directed to prospective Taiwanese elementary teachers. Myeong (1990) tested the structural integrity of the TRA model in predicting Korean high school students' choice of the science rather than humanities track at the completion of grade 10. With the introduction of the TPB the model has been used to determine the intentions of science teachers to use investigative teaching methods (Crawley, 1990), students' intention to enroll in physics (Crawley & Black, in press), and to study the effects of

belief-based messages designed to persuade Hispanic-American students living in a rural Texas community to enroll in chemistry (Crawley & Koballa, 1990).

With the shift from behaviorism to cognitive psychology, a change in social psychology and attitude studies also took place. As the advent of cognitive psychology has encouraged the study of declarative and procedural knowledge (Gagné, E., 1985), so social psychology has recognized the recipient of a communication as an "... active information processor who manipulates, elaborates, and integrates the information as it is received" (Petty, Ostrom & Brock, 1981, p. xiv). McGuire (1960) first called attention to an information processing approach when he defined step five of a 12-step model of information processing as "generating related cognitions." McGuire's model, was followed by the cognitive response approach (Greenwald, 1968) which became both theoretically and pragmatically useful as conditions for attention to the arguments of the message (central routes to persuasion) and conditions for attention to factors surrounding the message (peripheral routes to persuasion) were made specific in the Elaboration Likelihood Model (ELM).

Petty and Cacioppo (1981, 1986a, 1986b) utilized the cognitive response point of view in the development of the ELM of persuasion. Elaboration is the extent to which a person carefully thinks about issue-relevant information (Petty & Cacioppo, 1986a). When conditions foster personal motivation and ability to engage in issue-relevant thinking, the likelihood of elaboration is said to be high. When issue-relevant elaboration is high, individuals are more likely to integrate new arguments into existing belief structures. Variables which are more likely to foster elaboration and subsequent belief changes as a result of persuasion include: (a) high personal relevance, (b) persuasion context/ limitation of external distraction, (c) understandability of the message, (d) conditions providing greater message scrutiny, (e) message biasing (pro

or con), (f) no forewarning of message issue, (g) the subject's prior information relevant to the issue and (h) personal need for cognition. Greater central processing (elaboration) of the message by subjects has been shown to have a more lasting effect, permit greater prediction of behavior, and support greater resistance to counterpersuasion (Petty & Cacioppo, 1986b).

The ELM "provides a fairly general framework for organizing, categorizing, and understanding the basic processes underlying the effectiveness of persuasive communication" (Petty & Cacioppo, 1986b, p. 125). Two types of message processing are postulated by the ELM. The most important is the central processing route, which involves a "careful and thoughtful consideration of the true merits of the information presented in support of an advocacy" (1986b, p. 125). An individual who process a message using the peripheral route operates from cues in the persuasion context that "induce change without necessitating scrutiny of the true merits of the information presented" (1986b, p. 125). The likelihood of a message being elaborated depends upon the ability and motivation of the audience to focus on the arguments of the message and not the superficial features of the message.

Cognitive response approach methods have provided the research community with a method for the study of communication and persuasion. However, the methods do not provide suggestions for developing messages that are effective for a specific audience (Bradac, 1989). Once identified, salient beliefs can be used to develop messages appropriate to the target audience (Bradac, 1989, p. 33).

Awareness of the most effective means of social influence is very important in changing behavior. Using the theory of planned behavior, the underlying belief determinants related to a specific behavior can be identified for members of the target audience. Information can be directed toward the salient beliefs most potent in producing

the desired change in attitude, subjective norm, perceived behavioral control, and intention which ultimately determines behavior. Using communication and persuasion methods that encourage central rather than peripheral processing increases the likelihood that belief-based message arguments will be attended to and retained.

## Method

### Subjects

Students participating in this study were enrolled in the ninth or tenth grade in three high schools located in an urban school district that serves a community with a majority of Hispanic-American citizens located in south-central Texas. Participants in the preliminary open-ended survey of beliefs were enrolled in biology classes taught by four different teachers in two different high schools. A total of 97 ninth and tenth grade students in School A and C, 99% of whom were ethnically Hispanic, completed the preliminary Chemistry Interest Survey (CIS). In the main study which consisted of 93% and 88% of the students enrolled in physical science classes in schools A and B, respectively., all students enrolled in the classes of participating teachers had completed preregistration for the Fall Semester, 1990. Eighteen percent of the 456 students surveyed had preregistered for chemistry in the Fall, 1990. Experimental and control group students were drawn from ninth and tenth grade ethnically Hispanic students who were not preregistered for chemistry, were bilingual and were enrolled in physical science classes in School A (N=76) and School B (N=150). Although Chemistry Interest Questionnaires (CIQ) responses were collected from preregistered students, they were excluded from the data analyses. Data are reported only from students who were eligible to take chemistry during the next school year but had not preregistered to do so.

Research Questions

1. What are the affective, normative, and control beliefs of ethnically Hispanic students residing in an urban, Hispanic-American community relative to their intentions to enroll in high school chemistry in September, 1990?
2. Is the theory of planned behavior a valid model for explaining variations in students' intention to enroll in chemistry in September, 1990?
3. Which model determinants contribute most to students' intention to enroll in chemistry in high school in September, 1990?
4. Does a message (intervention) which addresses students' salient beliefs modify their beliefs and chemistry enrollment intentions?

Experimental Design

The design of the experimental portion of this research (research question four), posttest-only control group, was selected because methodologists, including Campbell and Stanley (1963) and others (Insko, 1967; Rosnow, 1981; Mason & Kahle, 1989), have cautioned that in an attitude study a pretest may influence a person's attitude to some degree. Intact classes of students participated in the study. Belief data were collected from students in Schools A and C using the preliminary Chemistry Interest Survey. These data were content analyzed to determine students' salient beliefs. These beliefs then were used to construct the persuasive message and the final questionnaire, the Chemistry Interest Questionnaire, for use in the experimental study. Experimental and control groups were drawn from the same sample and from the same teacher. To prevent contamination, each of the two treatments was assigned to a different school. One treatment group (School A) read and listened to the message and answered an open-ended survey ("quiz") afterward. The other treatment group (School B) read and listened to the message and took the written message home to be read and discussed with parents. In

School B open-ended survey ("quiz") materials were completed by students with their parents, signed by parents, and returned to school the next day. A majority of parents of students in school B (53%) signed and returned the completed survey. All phases of the study were completed in approximately one month.

Preliminary Survey

The Chemistry Interest Survey (CIS) was used to determine the modal behavioral, social, and control beliefs of Hispanic-American students about enrolling in chemistry in the Fall, 1990. The CIS consisted of nine open-ended questions, following the method described by Ajzen and Fishbein (1980, p. 262), and took about ten minutes to complete. Salient beliefs were used to construct the persuasive message and the Chemistry Interest Questionnaire.

Message Construction and Presentation

Eight key factors were considered in the development of the persuasive message in order to encourage central processing of the message arguments, according to the ELM (Petty and Cacioppo (1986b). Personal relevance was demonstrated by indicating the ways in which taking elective chemistry would benefit students' educational and career plans. In order to provide a familiar persuasion context and limit distraction from external sources, the message was presented to students in their classrooms by their teacher. To increase student understandability of the message, arguments in written and audiotaped forms were presented in the same language that was generated by students on the CIS. The message, stressing the professional and personal usefulness of chemistry, was spoken by a young Hispanic-American woman biochemist working in the local scientific community. In order to encourage greater scrutiny of the message arguments, before hearing the message students were told that they would be given a quiz afterward. Positive message biasing supported beliefs favorable to enrolling in chemistry and

admitted and counterargued unfavorable beliefs. The message answered questions related to their prior knowledge of the issue revealed by student responses to the CIS. Students were not forewarned of the message topic.

A message protocol was developed in which, favorable beliefs were reinforced with supportive statements and positive, concrete examples. Unfavorable beliefs were identified, acknowledged, and then discredited by providing information to the contrary, downplaying the importance of the negative aspect, and offering favorable concrete counterarguments. This method of message development adhered to strategies similar to those suggested by Stutman and Newell (1984) and Koballa (1989).

Instrumentation

The Chemistry Interest Questionnaire (CIQ) was developed in accordance with the methodology of the theory of planned behavior (Ajzen & Fishbein, 1980, p. 265 ff.; Ajzen & Madden, 1986; Ajzen, 1989). The CIQ measured students' post-intervention beliefs, intentions, and interests in taking chemistry in high school in September, 1990, and provided information on the dependent variables to be examined. The CIQ consisted of 61 items. Eleven items provided direct measures of key model variables: (a) Behavioral Intention (BI), (b) Attitude toward the Behavior (AB), Subjective Norm (SN), and (d) Perceived Behavioral Control (PBC). The remaining fifty items provided information used to determine belief-based estimates of attitude, subjective norm, and perceived behavioral control. Four semantic differential scales were used to obtain a direct measure of attitude. Other items used 7-point, "likely-unlikely" scales for outcomes, or "good-bad" scales for evaluation. Indirect belief scoring employed expectancy-value measures (Ajzen & Fishbein, 1980; Ajzen, 1989), that is, the response to a belief statement of an expected outcome was multiplied by the evaluation a subject personally placed on the outcome. The sum of expectancy-value measures for

each domain results in an estimate of the value of that domain. Information for several external variables was also collected: (a) gender, (b) ethnicity, (c) school, (d) teacher, (e) grade level, (f) type of class (basic or regular), (g) language orientation (English/bilingual vs. monolingual Spanish), and (h) educational and career goals.

Most test-retest reliability coefficients for direct and belief-based estimates of scale scores on the CIQ fell within the range of .72 to .52. The only exception was the value of .11 determined for the belief-based estimate of perceived behavioral control. This value was improved to .52 through use of theory trimming (Pedhazur, 1982, p. 616).

The CIQ was examined for three types of validity: (a) content, (b) construct, and (c) discriminant. Beliefs elicited from students concerning enrollment in chemistry in this study were highly similar to those found in other studies of enrollment intentions (Crawley and Black, in press; Crawley & Coe, 1990; Crawley & Koballa, 1990), which supports the beliefs as representing valid content for the TPB domains. Construct validity was tested by computing intercorrelations among TPB model variables. Values ranged from a high .68 ($p \leq .001$) for the correlation between AB and BI to a low of .30 ($p \leq .001$) for the correlation between the trimmed, belief-based estimate of PBC and its direct measure.

Discriminant validity of the CIQ was demonstrated by the model's ability to distinguish between two groups: (a) students preregistered for chemistry and (b) students who decided not to preregister for chemistry. Significant differences were detected between members of the two groups on directs measures of BI, AB, SN, and PBC ($p \leq .0005$). For expectancy-value estimates, group differences were detected on seven of nine behavioral beliefs ($p \leq .03$), all normative beliefs ($p \leq .001$), and one control belief, having good study habits ($p \leq .03$).

Data Analysis

Data collected from treatment and control groups in Schools A and B were analyzed using simple and multiple regression techniques, and path correlations were computed between model variables as specified in the TPB (Ajzen & Fishbein, 1980; Ajzen & Madden, 1986; Fishbein & Ajzen, 1975). Non-significant variables were excluded by theory trimming (Pedhazur, 1982) to improve the path coefficients. Experimental vs. control group results in each school were compared for significant differences by using analysis of variances techniques.

## Results

Identification of Salient Beliefs

A total of 233 behavioral belief responses were collected from 97 students. Nine modal beliefs, consequences of enrolling in chemistry, were identified and accounted for 86% of responses. Behavioral beliefs included (rank ordered): (a) learn more, (b) more work for me, (c) reach my career goal, (d) good experience, (e) gain an educational advantage, (f) learn to do chemistry experiments, (g) reach my educational goal, (h) hurt my grade point average, and (i) have to study more. A total of 220 referents influenced students chemistry enrollment intentions. In order of frequency mentioned these referents included: (a) parent/guardian, (b) siblings or other relatives, (c) friends (tied with siblings), (d) science teacher, (e) counselor or principal, and (f) other teachers. Counselor/principal and other teachers were deleted as salient referents as they accounted for only 4% of the mentions. Fewer total responses were elicited for control beliefs (164). These beliefs were reduced to eight salient controls, which accounted for 76% of the total responses. Salient factors thought to facilitate or inhibit chemistry enrollment included (in order of mentions): (a) prior knowledge of chemistry, (b) knowing the chemistry teacher, (c) good study habits, (d)

hearing that there was increased homework, (d) working in groups with friends, (e) lack of familiarity with chemistry, (f) fear of failure, and (g) having other courses or activities compete for my study time.

Relationships between Model Variables

The interrelationships of the determinants of behavioral intention (research question 2) were evaluated by employing simple and multiple regression techniques. Two levels of analyses were performed. At the first level, behavioral intention served as the dependent variable, and attitude toward the behavior (AB), subjective norm (SN), and perceived behavioral control (PBC) served as predictor variables. At the second level of analysis, belief-based estimates served as predictors of their respective model variables (AB, SN, and PBC). Using data obtained from the combined group of students (chemistry preregistrants and non-preregistrants) the analysis revealed that the three model variables contributed significantly to the prediction of BI ($R = .70$, $p \leq .001$) but in varying degrees. The greatest contribution to the prediction of BI came from AB ($\beta = .58$, $p \leq .001$), followed by SN ($\beta = .15$, $p \leq .001$) and PBC ($\beta = .10$, $p \leq .01$).

The extent to which the trimmed set of beliefs estimate the respective model variables was also tested using simple regression techniques. Using data for the combined group, the sum of the behavioral beliefs weighted by the respective outcome evaluation were shown to be predictive of AB ($R = .64$, $p \leq .001$). The sums of normative beliefs weighted by the respective motivation to comply and control beliefs weighted by the respective facilitative/inhibitive factor were also found to be predictive of SN ($R = .61$, $p \leq .001$) and PBC ($R = .30$, $p \leq .001$), respectively.

None of the external variables was found to be significantly related to behavioral intention, attitude toward behavior, subjective norm, or perceived behavioral control for students in the combined group. Analysis of variance tests conducted to determine the

population integrity of the two schools indicated no significant difference ($p \leq .05$) between schools on any of the four model variables or the three belief-based estimates. Similarly, analyses revealed non-significant effects due to teacher influence.

Determination of Dominant Beliefs

Theory trimming was used to reduce the number of salient beliefs to a set of dominant beliefs (research question 3) which could be shown to be significantly predictive each intention determinant (AB, SN, and PBC). Data for the combined group of students ($N = 456$) were analyzed using forward, backward, and stepwise regression techniques for each of the three sets of salient beliefs and its outcome measure, corresponding to AB, SN, and PBC components. Five significant personal beliefs survived the regression analyses, each having similar beta weights varying from $\beta = .15$ to $\beta = .18$. These beliefs represented primary outcomes associated with enrolling in chemistry and included: (a) achieving my educational goals, (b) learn more, (c) a good experience, (d) give me an educational advantage, and (e) help me toward my career goal. Three referents were found to be of primary importance ($p \leq .001$) to students when deciding whether or not to enroll in chemistry. Primary support was provided by parents or guardians ($\beta = .43$), friends ($\beta = .20$), and the science teacher ($\beta = .14$). Possessing good study habits ($\beta = .19$) and a prior knowledge of chemistry ($\beta = .16$) were the primary obstacles controlling students' decision to enroll in chemistry.

Message Effects

The trimmed TPB model and data obtained from students who declined to register for chemistry were used to determine the effects of the experimental intervention. Data were analyzed using ANOVA tests to detect differences between each treatment and its control groups attributable to the message effects. When students alone received the

message (School A), there were no significant differences detected between the treatment group and its control on any of the four model outcomes, namely BI, AB, SN, and PBC. Results of similar analyses conducted on data obtained from students (School B) in the student-and-parent message group and its control group, however, identified differences in BI [$F(1,148) = 6.9$, $p = .0095$), SN ($F(1,148) = 10.86$, $p = .0012$), and PBC ($F(1,148) = 5.04$, $p = .0236$) but not AB ($F(1,148) = 2.73$, $p = .1008$). Results of significance tests for the message effects are found in Table 1.

- - - - - - - - - - - - - - - - - - -

Insert Table 1 about here

- - - - - - - - - - - - - - - - - - -

Comparisons between the experimental and control groups of School B indicated that there was a significant difference in the direct measures of subjective norm ($p = .0012$) and in perceived behavioral control ($p = .0263$). Using the trimmed TPB model the belief-based estimate of subjective norm was found to be significantly related to its direct measure counterpart ($p = .0009$). This was not the case for the PBC component. The belief-based estimate of perceived behavioral control was not significantly related to the direct measure. Differences in subjective norm between experimental and control groups in School B were found to be attributable to differences in influence of two salient referents: (a) the science teacher ($p = .0001$) and the parent/guardian ($p = .0019$). Results of tests for differences in underlying beliefs attributable to message effects are found in Table 2.

- - - - - - - - - - - - - - - - - - -

Insert Table 2 about here

- - - - - - - - - - - - - - - - - - -

Significant differences were also detected in perceived behavioral control related to the decision to enroll in chemistry in the Fall, 1990 (PBC, the direct measure). Since control beliefs were not found to be a good estimate of the direct measure of perceived behavioral control, differences in beliefs between experimental- and control-group students were not tested.

## Discussion

Results of this investigation are of practical as well as theoretical importance. They provide evidence that interest among Hispanic-American students in the study of chemistry can be enhanced through the systematic application of models from social psychology. Attitude change was effected, in this investigation, by presenting a belief-based, persuasive message under conditions suggested by the Elaboration Likelihood and Planned Behavior models to students and their parents/guardians. Results of significance tests show that belief-based messages can significantly alter students' chemistry enrollment intentions for the following year. Contrary to the popular belief that students must be encouraged early in their schooling if they are to continue with science coursework beyond the required courses, this intervention experiment suggests that interest in elective science study can be changed. Students will express an interest in continuing their science study by enrolling in chemistry provided they and their parents/guardians are provided with information related to the consequences, social support, and facilitative and inhibitive factors that students perceive to exist. Reviewing arguments in class and at home in support of enrolling in chemistry results in an added level of encouragement from teachers and parents. This encouragement is sufficient to alter the enrollment intentions of students who have decided on their own not to preregister for chemistry in the upcoming school year. On the other hand, a

belief-based message presented to students alone, without the mentorship of parents or guardians, is not sufficiently persuasive to alter their enrollment intentions.

Results of this study support use of the theory of planned behavior and the elaboration likelihood models in attitude-behavior-change interventions. Identification and selection of beliefs targeted for change is possible by using the techniques specified in the theory of planned behavior. Once identified, belief-based arguments can be developed for students and their parents using message construction and presentation principles described in the elaboration likelihood model.

The effectiveness of the internal structure and relationship among the constructs in the TPB model needs further study. For the model determinants, the belief-based estimates of perceived behavioral control seem to be the least stable and meaningful. Only one of ten control beliefs proved to discriminate between two rather different groups of students, chemistry preregistrants and non-preregistrants. Test-retest reliability estimates indicate that students beliefs about perceived behavioral factors were unstable. In early applications of the TPB, Ajzen & Madden (1986) suggest that PBC factors may either effect behavior directly or influence behavior indirectly through behavioral intention, as do attitude and subjective norm. Ajzen (1987) further suggests that individuals lacking information about the behavior of interest may be unaware of the extent to which they possess the requisite opportunities, skills, or resources to engage in the behavior.

## Conclusions and Recommendations

Urban Hispanic-American students facing the decision to enroll in chemistry, although appearing to be independent-minded, seem to benefit from support from home and school. This support appears to effect change in intentions even as late as one month following the preregistration period. The theory of planned behavior and the elaboration

likelihood model of persuasion provide important theoretical bases for future investigations of attitude-behavior change among other groups of persons who are underrepresented in the science and engineering professions.

Several recommendations can be made based on the results of this study. School districts should identify and monitor on a regular basis the beliefs of high school students about the study of science. In doing so valuable information is gained. Working as a team science teachers, parents, and counselors can actively encourage students to continue their study of science beyond the courses required for graduation. Partnerships should be formed between science education researchers and school persons to serve as research teams to monitor the schools progress in promoting advanced science study, especially among students who have expressed little interest in further study. Additional investigations also are needed to identify the beliefs underlying students' intentions to enroll in algebra 2 and physics. These two courses, in addition to chemistry, have been shown to be key courses taken by students intent on remaining in the science and engineering pipeline (U.S. Congress, Office of Technology Assessment, 1988).

References

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl, & J. Beckman, Action Control: From cognition to behavior. (pp. 11-39). NY: Springer-Verlag.

Ajzen, I. (1987). Attitudes, traits, and actions: Dispositional prediction of behavior in personality and social psychology. Advances in Experimental Social Psychology, 20, 1-63.

Ajzen, I. (1988). Attitudes, personality, and behavior. Chicago, IL: The Dorsey Press.

Ajzen, I. (1989). Attitude structure and behavior. In A. R. Pratkanis, S. J. Beckler, & A. G. Greenwald (Eds.), Attitude structure and function. Hillsdale, NJ: Lawrence Erlbaum Associates.

Ajzen, I., & Fishbein, M. (1980). Understanding Attitudes and Predicting Social Behavior. Englewood Cliffs, NJ: Prentice-Hall.

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavior control. Journal of Experimental Social Psychology, 22, 453-474.

Bradac, J. J. (Ed.). (1989). Message effects in communication science. Newbury Park, CA: SAGE Publications.

Campbell, D. T., & Stanley, J. C. (1963). Experimental and quasi-experimental designs for research. Chicago, IL: Rand McNally.

Chen, C. S. (1988). Cognitive style and intention change: The effects of anecdotal and data-summary persuasive strategies on teachers' intentions to teach about the environment. (Doctoral dissertation, University of Texas at Austin, 1988). Dissertation Abstracts International, 49, 3341-A.

Crawley, F. E. (1990). Intentions of science teachers to use investigative teaching methods: A test of the theory of planned behavior. Journal of Research in Science Teaching, 27(7), 685-697.

Crawley, F. E., & Black, C. B. (In press). Causal modeling of secondary science students' intentions to enroll in physics. Journal of Research in Science Teaching.

Crawley, F. E., & Coe, A. S. (1990). Determinants of middle school students' intention to enroll in a high school science course: An application of the theory of reasoned action. Journal of Research in Science Teaching, 27(5), 461-476.

Crawley, F. E., & Koballa, T. R. (1990). Hispanic students' interest in chemistry project: Final report for the Pharr - San Juan - Alamo Independent School District. Unpublished report, Science Education Center, University of Texas at Austin.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention, and behavior: An introduction to theory and research. Reading, MA: Addison-Wesley.

Gagné, E. D. (1985). The cognitive psychology of school learning. Boston, MA: Little, Brown and Company.

Greenwald, A. G. (1968). Cognitive learning, cognitive response to persuasion, and attitude change. In A. Greenwald, T. Brock, & T. Ostrom (Eds.), Psychological foundations of attitudes, (pp. 147-170). New York: Academic Press.

Insko, C. A. (1967). Theories of attitude change. Englewood Cliffs, NJ: Prentice-Hall.

Koballa, T. R. (1988). The determinants of female junior high school students' intentions to enroll in elective physical science courses in high school: Testing the applicability of the theory of reasoned action. Journal of Research in Science Teaching, 25(6), 479-492.

Koballa, T. R. (1989). Using salient beliefs in designing a persuasive message about teaching energy conservation practices to children. Science Education, 73(5), 547-567.

MacCorquodale, P. (1983). Social influences on the participation of Mexican-American women in science. Tucson, AZ: Department of Sociology, University of Arizona. (ERIC Document Reproduction Service No. ED 234 944).

Mason, C. L., & Kahle, J. B. (1989). Student attitudes toward science and science-related careers: A program designed to promote a stimulating gender-free learning environment. Journal of Research in Science Teaching, 26(1), 25-39.

McGuire, W. (1960). A syllogistic analysis of cognitive relationships. In M. J. Rosenberg, & C. I. Hovland (Eds.), Attitude organization and change (pp. 65-111). New Haven, CT: Yale University Press.

Myeong, J. (1990). Predicting and understanding Korean high school students' science track choice: Testing the theory of reasoned action by structural equation modeling. (Doctoral dissertation, University of Texas at Austin, 1990). Dissertation Abstracts International.

National Center for Education Statistics. (1981). High school and beyond. Washington, DC: Author.

National Science Foundation. (July, 1989). Future scarcities of scientists and engineers: Problems and solutions [working draft]. Washington, DC: U.S. Government Printing Office.

Pedhazur, E. J. (1982). Multiple regression in behavioral research. (2nd Ed.). Fort Worth, TX: Holt, Rinehart and Winston.

Petty, R. E., & Cacioppo, J. T. (1981). Attitude and persuasion: Classic and contemporary approaches. Dubuque, IA: William C. Brown.

Petty, R. E., & Cacioppo, J. T. (1986a). Communication and persuasion: Central and peripheral routes to attitude change. NY: Springer-Verlag.

Petty, R. E., & Cacioppo, J. T. (1986b). The elaboration likelihood model of persuasion. Advances in Experimental Social Psychology, 19, 124-205.

Petty, R. E., Ostrom, T. M., & Brock, T. C. (1981). Cognitive response in persuasion. Hillsdale, NJ: Lawrence Erlbaum Associates.

Ray, B. D. (1991). The determinants of grades three to eight students' intentions to engage in laboratory and nonlaboratory science learning behavior. Journal of Research in Science Teaching, 28(2), 147-161.

Rosnow, R. L. (1981). Paradigms in transition: The methodology of social inquiry. New York: Oxford University Press.

Schifter, D. E., & Ajzen, I. (1985). Intention, perceived control, and weight loss: An application of the theory of planned behavior. Journal of personality and social psychology, 49(3), 843-851.

Stead, K. (1985). An exploration, using Ajzen and Fishbein's theory of reasoned action, of students' intentions to study or not to study science. (ERIC Document Reproduction Service No. ED 267 974).

Stutman, R. K., & Newell, S. E. (1984). Beliefs versus values: Salient beliefs in designing a persuasive message. The Western Journal of Speech Communication, 48, 362-372.

U. S. Bureau of the Census. (1980). Current population reports. (Series P-20, P-23). Washington, DC: U. S. Government Printing Office.

U. S. Department of Education. (1984). High school and beyond survey. Washington, DC: Author.

U. S. Department of Education. (1987). Fall enrollment in colleges and university surveys. Washington, DC: Author.

U.S. Congress, Office of Technology Assessment. (December, 1988). Elementary and Secondary Education for Science and Engineering—A Technical Memorandum (OTA-TM-SET-41). Washington, DC: U.S. Government Printing Office.

Vetter, B. M. (1989). Minorities gain, but white women lose ground. The AAAS Observer, (7), 10.

Table 1

Effects of Student and Parent Messages on Model Variables

| | School B | | | |
|---|---|---|---|---|
| | Mean | | | |
| Variable (Range) | experimental (N = 61) | control (N = 89) | $F_{(1, 148)}$ | p |
| BI (+6 to -6) | 0.80 (3.40) | -0.57 (3.23) | 6.9 | .0095 |
| AB (+12 to -12) | 2.1 (5.35) | 0.56 (5.76) | 2.73 | .1008 |
| SN (+21 to -21) | 4.56 (7.14) | 0.92 (6.27) | 10.86 | .0012 |
| PBC (+9 to -9) | 3.26 (3.34) | 2.01 (3.37) | 5.04 | .0263 |
| ∑b•e trimmed (+45 to -45) | 16.20 (15.67) | 11.10 (16.97) | 3.40 | .0645 |
| ∑nb•mc trimmed (+63 to -63) | 11.46 (16.38) | 3.12 (13.61) | 11.49 | .0009 |
| ∑cb•ec trimmed (+18 to -18) | 6.33 (6.24) | 5.59 (6.45) | .49 | .4867 |

Table 2

Normative beliefs: ANOVA comparisons for School B.

| | School B | | | |
|---|---|---|---|---|
| | Mean | | | |
| Variable Range = +9 to -9 | control | experimental | $F_{(1, 148)}$ | p |
| PG | 0.75 | 4.10 | 10.03 | .0019 |
| ST | 1.43 | 5.57 | 15.75 | .0001 |
| FR | 0.94 | 1.79 | 0.76 | .3837 |

Key to symbols: PG, parent/guardian; ST, science teacher; FR, friends.